Roberts. (M. J.)

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AND

PRACTICAL DEMONSTRATION OF THE WORKING

OF

# ROBERTS'

# *Improved Electro-Osteotome,*

NEW ELECTRICAL ILLUMINATING APPARATUS,
AND A NEW FORM OF PORTABLE
STORAGE BATTERY.

BY

MILTON JOSIAH ROBERTS, M. D.,
*Professor of Orthopedic Surgery and Mechanical Therapeutics in the New York Post-Graduate Medical School and Hospital; Visiting Orthopedic Surgeon to the City Hospitals on Randall's Island.*

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IN whatever direction we extend observation and research so as to harmonize facts, it always happens that the information thus acquired opens up an entirely new field for discovery. Hand in hand with the successive glimpses thus gained of new knowledge to be acquired comes the demand for better and more thoroughly elaborated instruments of scientific research. It thus happens that in many instances discovery comes to depend upon invention. The reverse of this statement is also true ; invention frequently depends upon discovery. There is, then, a reciprocal relationship existing between invention and discovery ; for, while freshly correlated facts, pointing out new truths of nature, serve as a basis or stimulus to invention, further progress in knowledge may, at any time, become extremely slow or absolutely impossible without invention, or, in other words, until some one makes a new application of correlated facts. Discovery and invention, then, are the handmaids of science. There is probably no stronger ally to the acquisition of verifiable knowledge than new and improved instruments.

The range of usefulness of our senses may be enormously increased by the invention of a new instrument or the improvement of an old one. The electrical telephone, the compound microscope, the telescope, the spectroscope, the microphone, the laryngoscope, the stethoscope, the æsthesiometer, the thermometer, the ophthalmoscope, and many other instruments might be named in support of this statement.

Instruments not only extend the range of our senses so that we can see, hear and feel what could not be seen, heard or felt without them, but they are also of the greatest possible aid in de-

termining the limitations of our sensory impressions, or, in other words, reducing to definite terms differences or similarities which we perceive by our unaided senses, or by the use of instruments. Under this head might be mentioned all instruments of precision, so called, such as, for instance, linear mensuration instruments, which enable us to determine the distance between two points; the difference in length between two limbs; or again such an instrument as will enable us to determine in definite terms the difference in the temperature of various parts of the body; or still again an instrument which will enable us to determine in degrees the extent of bodily deformities.*

New applications of force or development of increased power may result from the invention of new instruments. In illustration of this fact the hydraulic press may be cited, by the aid of which enormous power was developed, which, when applied to the compression of gases, resulted in the discovery of a new law, the law of the compressibility of gases. In surgery the osteoclast is an instrument by the use of which the surgeon is enabled to exert great power—sufficient to fracture a bone at a given point for the correction of deformity.

Then, again, the invention of a new instrument often facilitates the execution of work so enormously that new and greater undertakings not only become possible, but are made absolutely practicable. The locomotive engine and the steamship furnish us with facilities for travel which enable one to complete with ease and comfort a journey in the course of a few days or weeks which prior to their introduction would have required many weeks or months.

Were I to detail all the ways in which invention aids discovery and promotes the acquisition of knowledge, I would have to write a very large volume. My only object in referring to the subject on the present occasion is to call attention to the proper relationship which exists between the acquisition of verifiable knowledge and invention. I do this because I have so frequently heard it remarked by medical gentlemen, that though they were continually using instruments they found no occasion for the invention or elaboration of others than those in general use; that whatever work could be done at all could be as well done with the existing armamentarium as by the use of any of the so-called improve-

* I have called attention to three instruments of precision, designed with special reference to diastrophometric (διαστροφὴ, a distortion, and μέτρον, a measure) observations, in a recent paper entitled, "Anatomical Geometry and Toponomy; an Introduction to the Scientific Study of Deformities, with a description of New Mathematical Instruments." Read before the Medical Society of the State of New York, February 3, 1885.

ments ; and furthermore that the only motive which they believed most inventors had was to devise or modify some instrument in order that it might bear their name.

This is indeed a poor apology for making no endeavor to advance knowledge and increase our resources for the relief of human suffering by invention. The indications for invention in medicine are nowhere more clearly seen than in the department of bone surgery. We are still almost wholly dependent upon hand power and hand implements for cutting bone, while in other mechanical arts a great variety of machines have been invented for working hard materials of every kind. The surgeon of the present day who, in the face of a full knowledge of the existence and daily advantageous use in the arts of varied forms of machines impelled by other force than muscular power, and designed for the rapid and accurate cutting of hard substances under all sorts of conditions, continues to execute his conservative operations upon bone by the use of drills, trephines, saws and chisels, all *exclusively* worked by his own muscular power, would, from a machinal standpoint, seem to be almost comparable to the primitive man who, looking with superstitious awe upon the forces of nature as manifested by the lifeless activity about him, continued to propel his boat with poles and oars for ages before he dared venture to utilize the force of the wind, by spreading a sheet before it, to waft his boat along ; who ground his grain between stones and turned his mill by muscular effort for ages more before he overcame his timidity sufficiently to utilize for this purpose the force of the flowing water in the babbling brook as it rushed on its way to join some mighty river.

There are, however, some extenuating statements to be made other than the necessary expenditure of time and money in explanation of the tardiness of invention, by surgeons, of machines impelled by other forces than their own muscular effort, and designed for operating on the bones of living human beings. In the first place, there is a mistaken tendency on the part of recognized medical authorities to represent our knowledge as assuming an approximately complete character, forgetting as has already been stated, that each new correlation of facts opens up new fields for investigation. Then, again, the surgeon rarely begins his work with a thorough knowledge of mechanics, and this deficiency not being made up in after years, he is necessarily slow in taking the first step towards invention, viz., in the recognition of the need of improvement; and he is still slower in taking the second step, which it is essential he should take before he even makes the first

attempt at improvement, viz., that the bringing of this about is a feasible undertaking.

If we for a moment compare our surgical armamentarium for operating in soft parts with that in general use for operating in hard tissues the disparity between the two is at once strikingly manifest. It is to describe and make a demonstration of the practical working of an instrument which, in my judgment, will help to make good this disparity that I have come before you to-night. The instrument referred to is what I have called the electro-osteotome. The attention of the medical profession was first publicly directed to this instrument by a short communication to the North-Western Medical and Surgical Society of this city, October 17, 1883.*

The instrument as originally described (see Fig. 1., which represents it as it appears when suspended and grasped by the hand of the surgeon ready for action) consists of a small electro-motor, supplied with electricity through insulated wires, from a powerful ten-cell primary zinc carbon battery, and carrying a circular saw that revolves in a plane parallel with that of the central shaft. A hollow cylinder with a collar-like base is firmly screwed to the end plate of the motor. Upon this a soft rubber hand-piece, fashioned like that of a carpenter's chisel, is slipped and fastened in position, forming the handle of

Fig. 1.

* The Electro-osteotome; a new Instrument for the performance of the operation of osteotomy, and a New Form of Retractor. *New York Medical Record*, October 27, 1883.

the instrument, and enabling the surgeon to control it when operating. The central shaft of the motor is continuous through the hollow cylinder. At its distal end a right-angle miter-gearing connects it with the saw-bearing point. A metal shield guards the proximal aspect of the serrated blade. Shields are provided for each size of saw. Four sizes of circular saws, viz.: 32 (1¼ inch), 41 (1⅝ inch), 51 (2 inches), and 63 (2½ inches) millimeters in diameter were originally provided.

Upon the plate opposite the end of the motor to which the hand-piece is attached are two binding-posts, which receive the ends of the insulated wires connecting the instrument with the battery.

When using the electro-osteotome it is suspended by a solid rubber cord, six or seven millimeters in diameter, from the cross-bar of an adjustable crane screwed to the edge of the operating table. In this way all weight is removed from the hand of the surgeon, leaving the instrument as thoroughly at his command as if it were a delicate probe.

In order to protect the soft parts when operating, a protecting retractor of the form shown in Fig. 2 was employed. Two such instruments as are here represented form a pair. They are introduced one at a time through the linear incision in the soft parts, carried down to the bone and passed around it much after the fashion of applying obstetric forceps. When in position they are pressed apart, so as to make room for the circular blade of the osteotome. By their use there is no possibility of injuring any of the soft parts while operating. The retractor here illustrated is provided with a double curve at each end, one large, the other small, so as to adapt it to large and small bones.


FIG. 2.

This was my invention as originally brought to the notice of the profession in October, 1883. In it I found myself the possessor of a machine that enabled me to make cross, oblique and linear sections of bone with exceeding ease, astonishing rapidity and great accuracy as to direction and extent of cut.

But its range of action was too narrow. Already I could see wider fields of usefulness pending its further elaboration and development. And now for the improvements which have been made up to the present time.

By reference to Fig. 1, it will be seen that the motor is entirely exposed. I soon learned that this was a source of peril to the operator; for, while intently watching the section of bone which was being made, if perchance he brought his head or face

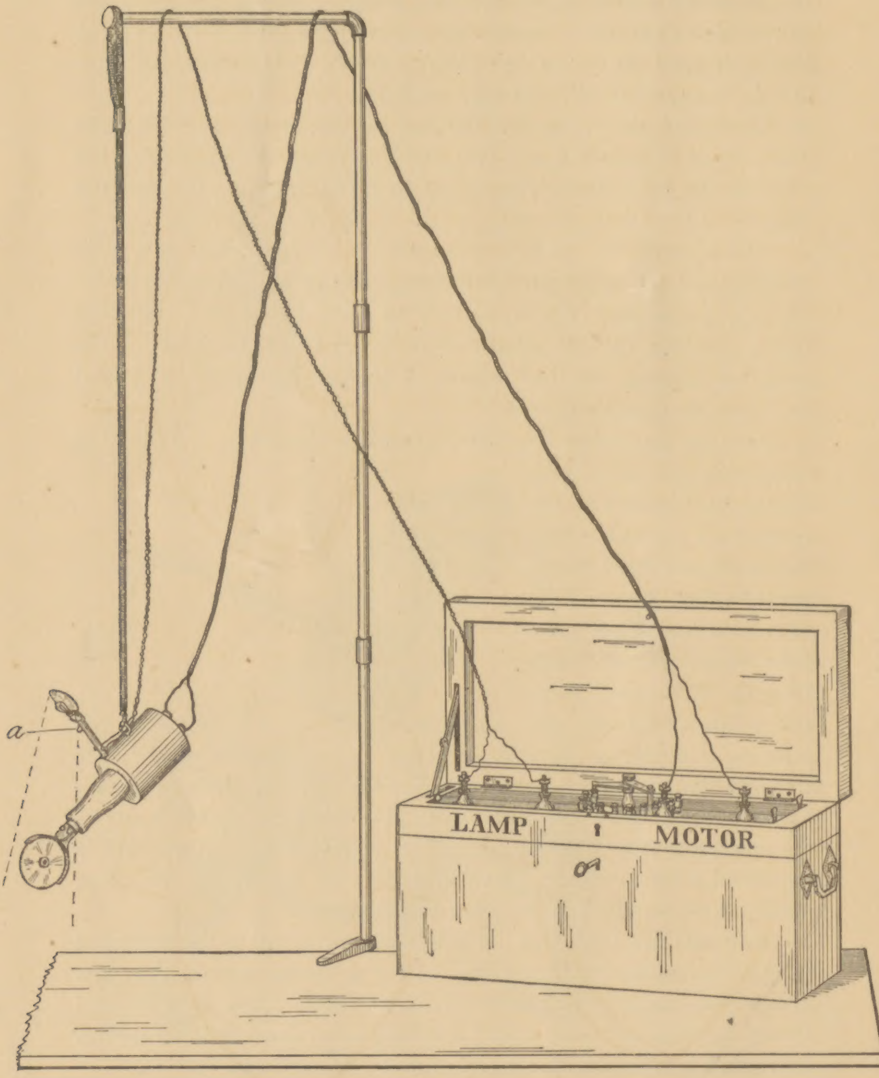


Fig. 3.

close to the instrument, he was in very great danger of losing part of his beard or the hair of his head by having it caught in the rapidly revolving armature of the motor. I soon came to realize

the importance of overcoming this objection; for on three occasions while operating I lost a goodly portion of the beard on the left side of my face. The objection referred to was first overcome by placing a thin and narrow ferrule of hard rubber over each end of the motor, so as to entirely shut out from view the revolving armature. Subsequently these were replaced by a section of large thin hard rubber tubing, which was passed over the motor, covering it entirely (see Fig. 3 on opposite page).

Another objection which demanded immediate attention pertained to the guards used to cover the proximal aspect of the saws, the object of which was to prevent blood from being thrown into the face of the operator and to avoid contact with the rapidly revolving saw blade. These guards originally consisted of two thin sheets of steel, separated by a narrow but thicker piece of metal at their proximal margin to which they were riveted (see Fig. 4, dotted line, which represents the position and width of the piece referred to). The guard passed over the saw and covered in nearly one-half of it. It was secured in position by means of a screw passed through its shank. The deep recess thus left between the two sides of the saw-guard served as a receptacle for blood and

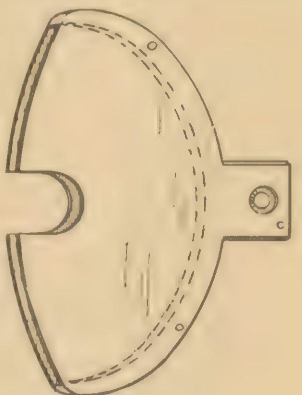


FIG. 4.

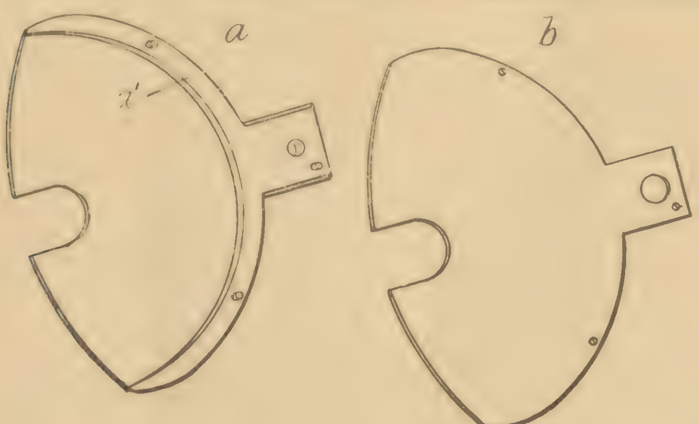


FIG. 5.

bone dust. The difficulty of cleaning such a cavity can readily be appreciated. In fact, it was practically impossible to keep it sur-

gically clean. To overcome this objection the saw-guard was made in two pieces (see Fig. 5, *a* and *b*). Only one of the sides of the saw-guard was riveted to the thick, narrow piece of metal on its proximal aspect (see Fig. 5, *a*). Three steady pins projecting from the thick narrow piece of metal served to keep the two parts of the guards in proper relationship with each other while being handled. A screw passing through the shank of the guard into the hand-piece served to hold both of them in place when in use. This arrangement answered for a time, but ultimately one plate was removed entirely, and the other cut down to a narrow strip. The thick piece of metal between the plates was entirely done away with. In its place a narrow rim was fixed at right angles to the side strip so as to prevent the centrifugal force of the revolving saw blade throwing blood into the face of the operator (see Fig. 6). Practical tests have shown this form of saw-guard very satisfactorily.

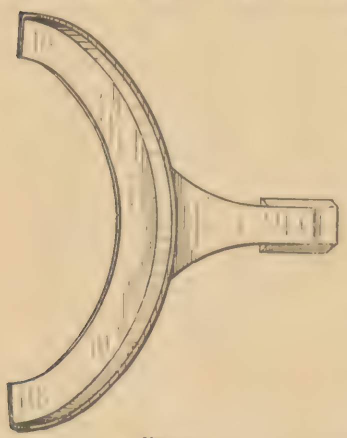

FIG. 6.

A third objection to the instrument was the necessity of having an assistant to lower the battery plates into the fluid when it was desired to start the motor and to draw them out in order to stop it. To overcome this objection a simple switch was attached to the plate on the free end of the motor so that it could be opened and closed at pleasure. This increased the independence of the operator, for after the battery plates were lowered into the fluid the instrument was not set in motion until the desired moment, when by the use of his free hand (one being employed to grasp the handle of the motor) the operator closed the circuit by means of this switch, and the motor was set in motion. Upon completing a section of bone, the operator, without waiting for the battery plates to be withdrawn from the fluid, can open the circuit by means of the switch and stop the instrument. These improvements added greatly to the ease and facility of using the osteotome.

Ambitious to widen the range of usefulness of my instrument I determined to so alter it that I would be able to use drills, burrs and trephines as well as circular saws. To this end the circular saw mountings were unscrewed from the free extremity of the hand-piece, exposing the beveled gear on the extreme end of the

extended shaft of the motor. I devised and adapted a head-piece provided with a clutch to fit into the beveled gear when it was secured in position on the end of the hand-piece (see Fig. 7). Tests with this head-piece proved conclusively that drills and trephines could be driven through bone with great ease and rapidity.

Fig. 7.

An ordinary trephine, one-half of an inch in diameter, of pattern shown in Fig. 8, was adapted to my instrument. With it I was enabled to remove a button of bone from the skull in eight seconds, the thickness of the bone at the point of operation being a full quarter of an inch. The curves and teeth in these trephines are filed by hand, and are therefore not very regular. The consequence was that though bone was readily cut with it the instrument did not work as smoothly as was desirable. I therefore had one constructed of the pattern shown in Fig. 9, which is a

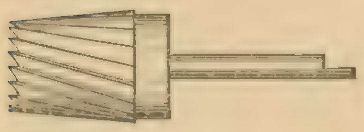

Fig. 8.

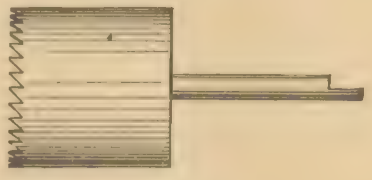

Fig. 9.

very great improvement on the old one. The sides of this trephine are perfectly parallel, and the teeth all slant in one direction. With an instrument of this pattern, ⅞ of an inch in diameter, I removed a button of bone in five seconds, the skull at the point of operation being fully as thick as above stated. The passage of the trephine through the bone is accomplished with such ease that the position of the cutting edge can be accurately estimated by the operator. In propelling a trephine by muscular power so much force is required to be exerted by the operator that tactile sensibility is practically annulled.

All this was very satisfactory, but in operations requiring the use of both circular saws and drills, I found myself seriously embarrassed in making the necessary changes incident to the alternate use of these instruments. The time consumed in making these changes almost precluded the use of circular saws and drills in the same operation. It was necessary to remove six small screws to rid the instrument of the circular saw attachment, and

to introduce four small screws to secure the attachment of the head-piece for carrying the drills. The embarrassment experienced in consequence of this defect in the osteotome led to my elaborating interchangeable head-pieces which could be alternately screwed to the end of the shaft of the instrument. See Figs. 10 and 11, which represent the two views of the circular saw head-piece, and Fig. 12, which represents the head-piece for carrying the drills, trephines and burrs. The dotted lines in Fig. 10 represent the position of the improved saw-guard illustrated in Fig. 6. The dotted lines in Fig. 11 and Fig. 12 represent the end of the hand-piece with the projecting beveled gear on the end shaft of the motor which passes through the hand-piece. In Fig. 11 there is a dotted line indicating the blade of the circular saw. Their construction is apparent from an examination of the cuts. Six sizes of circular saws, ranging from one to three inches in diameter, are now provided for the instrument, instead of four, the former number.

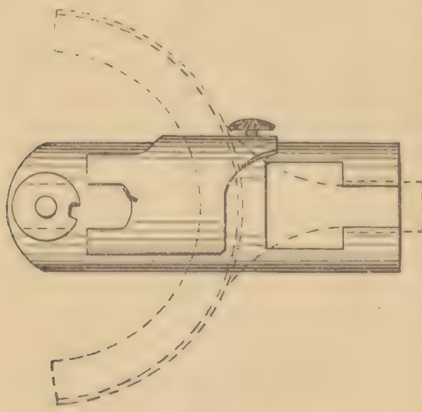

FIG. 10.

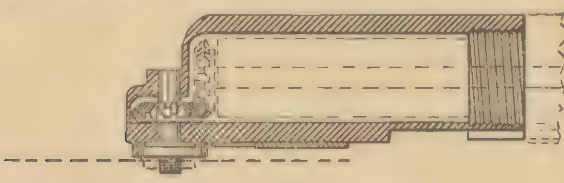

FIG. 11.

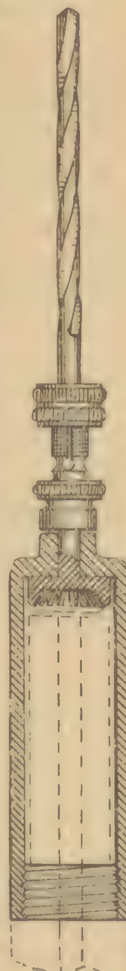

FIG. 12.

Finally, the motor is provided with a small electric light mounted on a pedestal, which is screwed into the edge of the end plate to which the hand-piece is attached (see Fig. 3). Behind the lamp is a reflector, which projects the rays of light directly upon the site of operation. This addition to the instrument was found desirable on account of insufficient light for operations late in the day. When

it is desired to use the light all that is necessary is to give a half-turn to a little thumb-screw indicated at *a*. Two cells of the battery are reserved for lighting purposes, and are connected with the lamp by independent insulated wires. The circuits for the lamp and the motor being entirely independent, either one alone or both at a time can be brought into use as desired. A very ingenious electric light has been devised by my friend, Dr. William C. Jarvis (see Fig. 13). It was especially designed for laryngological work, being attached to an ordinary head mirror. I think, however, it is well adapted for general lighting purposes.

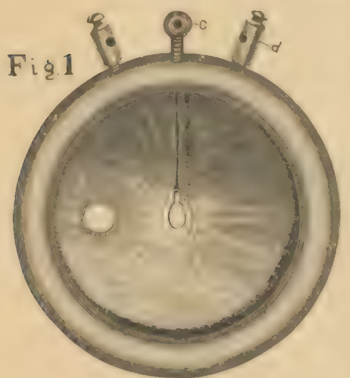

FIG. 13.

The form of retractor originally used (see Fig. 2) had several objections, the most prominent of which was that of being sharp at both ends. In placing them in position the operator was likely to cut his hand unless he exercised unusual care. Fig. 14 shows the different forms of protecting retractors, which I now use;

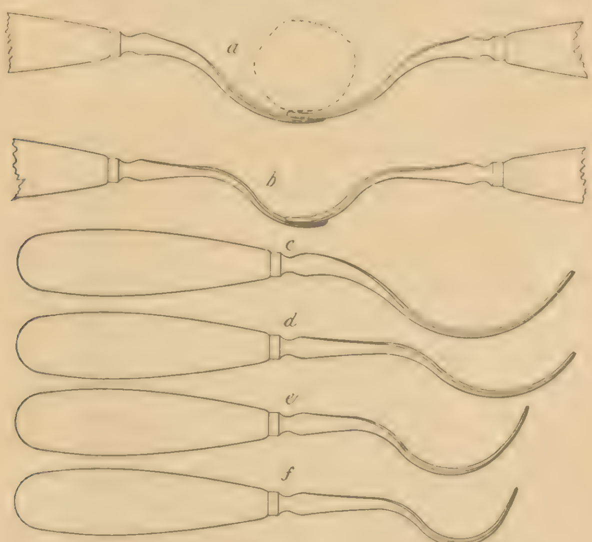

FIG. 14.

*a* and *b*, Fig. 14, represent two pairs of retractors of different curves, one designed for large and the other for small bones.

The form of retractors shown at *c*, *d*, *e* and *f* are used singly. It will be seen that they are provided with a longer blade, the curvatures being adapted to the different sizes of circular saws. They are introduced in precisely the same manner as described for the retractors shown in Fig. 3.

In conclusion I wish briefly to call your attention to a new form of storage battery. There is nothing novel in the construction of the storage cells; the novelty is simply in the form of the battery (see Fig. 15 and Fig. 3). In Fig. 3 the battery is repre-

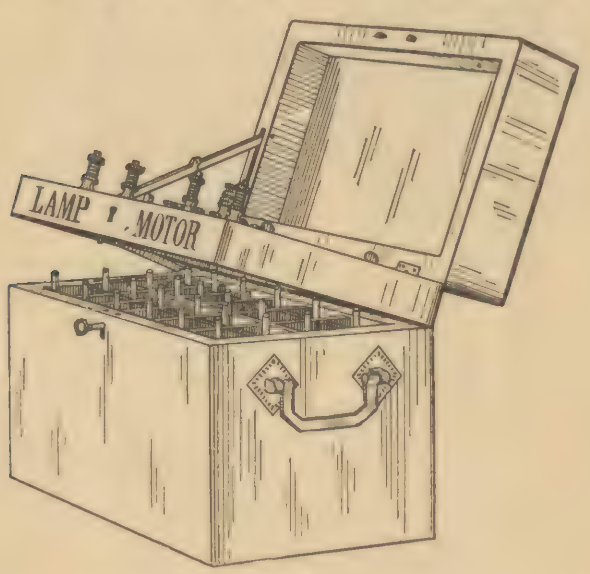


FIG. 15.

sented as it appears when in use. It contains twelve cells, all of which are so connected that they can be brought into the circuit for driving the motor. Two of the cells, however, are connected independently, and are designed to be used for lighting purposes. By means of the switch, however, which is connected with the motor circuit, the two cells ordinarily used for the lamp circuit can be cut out of the lamp circuit and brought into play for driving the motor. The switch-board is provided with two levers, by means of which in case a single cell in the battery is at fault it can be readily picked out from the others. As shown in Fig. 15, the cells of the battery can be exposed for inspection by the simple turn of a key.

Before closing I wish to say that I look upon the electro-osteotome, even in its present state of development, as making it feasi-

ble to perform successfully several new operations in bone surgery, which with the existing armamentarium it is not practicable to undertake. New operations are not only rendered practicable by using the electro-osteotome instead of the ordinary hand instrument, but in my judgment the vast majority of operations that are now performed upon bones can be executed with it, not only with greater dispatch and precision, but with far less shock to the patient and consequent risk of life.

105 Madison Avenue, New York.